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Feeding Dairy Cattle

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Feeding Dairy Cattle

Abstract
The dairy cow is a more efficient producer of human food than any other domestic animal. For each 100 pounds of digestible nutrients consumed she returns in her milk more than six times as much edible solids as the beef steer or mutton sheep yields in its carcass. As agriculture becomes more intense the farmer has to pay greater attention to economy of production, so it is becoming necessary for him not only to use the most economical type of animal but also to have it producing to the best of its ability.

To insure successful milk production two things are fundamentally necessary, a productive dairy cow and a liberal system of feeding. A good cow will produce well for a considerable time even on poor feed, but this is done at the expense of her own body and so if proper feed is not supplied she must produce less milk than she is really able to do and finally dry oft' when the stores of nutrients in her body are depleted. Lack of suitable feed explains why many cows in the corn belt are not producing well. They are fed on corn stalks and timothy hay with perhaps a little ear or shelled corn; in spite of this they produce wen for a few months after calving, but they soon dry up and arc idle until their next freshening.

For the successful feeding of dairy cows a knowledge is neccesary not only of the food materials required by the animals but also of the various classes and quantities of constituents in the feeds used.

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FEEDING DAIRY CATTLE

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

Animal Husbandry Section
Dairy Husbandry

Ames, Iowa

CONTENTS

FEEDING DAIRY CATTLE

By A. C. McCandlish

The dairy cow is a more efficient producer of human food than any other domestic animal. For each 100 pounds of digestible nutrients consumed she returns in her milk more than six times as much edible solids as the beef steer or mutton sheep yields in its carcass. As agriculture becomes more intense the farmer has to pay greater attention to economy of production, so it is becoming necessary for him not only to use the most economical type of animal but also to have it producing to the best of its ability.

To insure successful milk production two things are fundamentally necessary, a productive dairy cow and a liberal system of feeding. A good cow will produce well for a considerable time even on poor feed, but this is done at the expense of her own body and so if proper feed is not supplied she must produce less milk than she is really able to do and finally dry off when the stores of nutrients in her body are depleted. Lack of suitable feed explains why many cows in the corn belt are not producing well. They are fed on corn stalks and timothy hay with perhaps a little ear or shelled corn; in spite of this they produce well for a few months after calving, but they soon dry up and are idle until their next freshening.

For the successful feeding of dairy cows a knowledge is necessary not only of the food materials required by the animals but also of the various classes and quantities of constituents in the feeds used.

CONSTITUENTS OF FEEDS

Feeding stuffs are not simple substances but are composed of many complex chemical compounds. The constituents of feeds which are useful in the feeding of animals are called nutrients, and the various classes of these, proteins, carbohydrates, fats, ash and water, are defined below:

A nutrient is a compound, or group of compounds of similar composition, which aids in supporting animal life.

The proteins are complex organic compounds containing nitrogen. Other simpler nitrogenous substances, such as amids, are also present. These are sometimes grouped with the true protein and the whole called crude protein.

The carbohydrates are composed of carbon, hydrogen, and oxygen, the hydrogen and oxygen being present practically always in the proportions in which they occur in water. This group is subdivided into crude fiber and nitrogen-free extract. The crude fiber consists of materials such as are found in the woody parts of plants, while the best known examples of nitrogen free extract substances are starch and sugar.

The fats contain carbon, hydrogen and oxygen, but the hydrogen and oxygen are not present in the same proportions as in water.

The ash is the mineral part of the feeds.

Water, which needs no definition, occurs in all feeds and is exceedingly important.

FUNCTIONS OF FOOD NUTRIENTS

All the food nutrients consumed by an animal are not utilized. In its passage thru the stomach and intestines the feed is acted on by many digestive juices and part is absorbed from the alimentary tract and taken into the blood. It is this part of the ration, the digestible nutrients, that is of greatest importance. It is the digestible protein, digestible fat, and so on, that must be taken into account in making up a ration.

Each food nutrient has several functions to perform in the animal body. The proteins are used for building up and replacing muscular and other active tissue and are very essential for the welfare of the animal. When more protein than is necessary for tissue building is supplied it is used for the production of heat and energy. In pregnant animals protein is also needed for the growth of the fetus and after parturition a considerable amount of the nitrogenous constituents of the feed is used in the production of the milk proteins.

Carbohydrates, including both digestible fiber and nitrogen-free extract, are used largely for the production of heat and energy but may be converted into fats and stored in the body as such. Large amounts of them are used up in the production of the fat and sugar of milk. The fats are more concentrated heat and energy producers than any other of the food nutrients and are also used as material to be stored up in the body. They help in the production of the fat and other milk solids.

The proteins cannot be replaced by either fats or carbohydrates for the building of body or milk protein. As their heat and energy producing value is only equal to that of the carbohydrates and their cost is usually greater proteins should not be fed in excess if the most economical results are sought. The tissue and milk requirements for protein should be supplied by the feed and a little extra, as this has a stimulative action, but the nutrients needed for heat and energy production should be supplied mainly as fats and carbohydrates. The fats, pound for pound produce two and a quarter times as much heat and energy as do the carbohydrates or proteins.

Ash, though present in feeds in smaller proportions than any other food nutrient, is absolutely essential. Its main function is to build up bone in the animal, and also in the fetus of pregnant females, and to form the mineral portion of milk. It has other functions which though vital are less evident.

The water supplied to a cow, either in the feed or as drinking water, is required in the tissues and as a means of carrying the other nutrients from one part of the body to another and to the fetus and mammary glands. Its importance in the production of milk is easily seen when it is known that 87 per cent of milk is water.

DEFINITIONS OF FEEDS

The following definitions of feeding stuffs, officially adopted by the Association of Feed Control Officials of the United States, will give an idea as to the source, method of preparation, and general character of some of the more common feeds:

GENERAL DEFINITIONS

Meal is the clean, sound, ground product of the entire grain, cereal, or seed which it purports to represent.

Chop is a ground or chopped feed composed of one or more different cereals or by-products thereof. If it bears a name descriptive of the kind of cereals it must be made exclusively of the entire grains of those cereals.

Screenings are the smaller imperfect grains, weed seeds and other foreign material having feeding value, separated in cleaning the grain.

Alfalfa meal is the entire alfalfa hay ground, and does not contain an admixture of ground alfalfa straw or other foreign materials.

BREWERS' AND DISTILLERS' PRODUCTS

Brewers' dried grains are the properly dried residue from cereals obtained in the manufacture of beer.

Distillers' dried grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

Malt sprouts are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal, the source must be designated.

BUCKWHEAT PRODUCTS

Buckwheat shorts or buckwheat middlings are that portion of the buckwheat grain immediately inside of the hull after separation from the flour.

CORN PRODUCTS

Corn bran is the outer coating of the corn kernel.

Corn feed meal is the sifting obtained in the manufacture of cracked corn and table meal made from the whole grain.

Corn germ meal is a product in the manufacture of starch, glucose and other corn products and is the germ layer from which a part of the corn oil has been extracted.

Grits are the hard, flinty portions of Indian corn, without hulls and germ.

Hominy meal, hominy feed or hominy chop is a mixture of the bran coating, the germ and a part of the starchy portion of the corn kernel obtained in the manufacture of hominy grits for human consumption.

Corn gluten meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran, by the processes employed in the manufacture of corn starch and glucose. It may or may not contain corn solubles.

Corn gluten feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germ by the processes employed in the manufacture of corn starch and glucose. It may or may not contain corn solubles.

COTTON SEED PRODUCTS

Cottonseed meal is a product of the cottonseed only, composed principally of the kernel with such portions of the hull as is necessary in the manufacture of oil, provided that nothing shall be recognized as cottonseed meal

tnat does not conform to the foregoing definition and that does not contain at least 36 per cent of protein.

Choice cottonseed meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint and must contain at least 41 per cent of protein.

Prime cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and must contain at least 38.6 per cent of protein.

Good cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and must contain at least 36 per cent of protein.

Cottonseed feed is a mixture of cottonseed meal and cottonseed hulls, containing less than 36 per cent of protein.

Cold pressed cottonseed is the product resulting from subjecting the whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire cottonseed less the oil extracted.

Ground cold pressed cottonseed is the ground product resulting from subjecting the whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire ground cottonseed less the oil extracted.

LINSEED AND FLAX PRODUCTS

Linseed meal is the ground product obtained after extraction of part of the oil from ground flaxseed screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes.

Oil meal is the ground product obtained after the extraction of part of the oil by crushing, cooking and hydraulic pressure, or by crushing, heating, and the use of solvents from seeds which have been screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "oil meal" shall be understood to designate the product obtained from screened and cleaned flaxseed. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to the words "oil meal."

Old process oil meal is the ground product obtained after extraction of part of the oil by crushing, cooking and hydraulic pressure from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "old process oil meal" shall be understood to designate the product obtained from partially extracted, screened and cleaned flaxseed. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "old process oil meal."

New process oil meal is the ground product obtained after extraction of part of the oil by crushing, heating and by the use of solvents from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "new process oil meal" shall be understood to designate the product obtained from partially extracted, screened and cleaned flaxseed. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "new process oil meal."

OAT PRODUCTS

Oat groats are the kernels of the oat berry.

Oat hulls are the outer chaffy coverings of the oat grain.

Oat middlings are the floury portion of the oat groat obtained in the milling of rolled oats.

Oat shorts are the covering of the oat grain lying immediately inside the hull, being a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

Clipped oat by-product is the resultant by-product obtained in the manufacture of clipped oats. It may contain light, chaffy material broken from the ends of the hulls, empty hulls, light immature oats and dust. It must not contain an excessive amount of oat hulls.

WHEAT PRODUCTS

Wheat bran is the coarse outer coatings of the wheat berry obtained in the usual commercial milling process from wheat that has been cleaned and screened.

Shorts or standard middlings are the fine particles of the outer and inner bran separated from bran and white middlings.

Wheat white middlings or white middlings are that part of the offal of wheat intermediate between shorts or standard middlings and red dog.

Red dog is a low grade wheat flour containing the finer particles of bran.

THE CHARACTERISTICS OF FEEDING STUFFS

Feeding stuffs are as a rule divided into "concentrates" and "roughages." The concentrates are materials, such as the grains and factory by-products, which contain very little crude fiber and are very highly digestible. The roughages are bulky materials, like hay and silage, and are considerably more fibrous than the concentrates.

Concentrates

The concentrates are grouped here according to their origin, so far as possible, but occasionally it will be necessary to class them on the basis of their characteristics rather than their origin.

Corn. Corn is capable of providing a very large proportion not only of the roughages but also of the concentrates used on the dairy farms of Iowa. This feed is valuable chiefly on account of its carbohydrates, for tho it contains about 10 per cent of protein, other sources of this material are usually cheaper. It is also deficient in ash, particularly lime and sometimes phosphates. In the corn belt, corn must form the basis of the economical grain ration as it is usually the cheapest source of carbohydrates or energy-supplying material. But corn should not be fed as the sole concentrate, especially where the corn plant is also supplying the silage or other roughage used; it should be supplemented by other nitrogenous feeds. It will be found more profitable to feed corn to dairy cows as cracked corn or corn meal rather than as ear or shelled corn because the prepared forms are more completely utilized.

Soft Corn. The best way of handling a crop of soft corn is to put it in the silo, but sometimes this is not possible and the grain has to be fed. Pound for pound, soft corn has not as high a feeding value as well matured corn but when figured on the dry matter basis there is little difference, because, tho soft corn contains relatively less fat than mature corn, it as a rule contains more crude protein. There is no reason why soft corn can not be utilized economically by the dairy cow if it is fed carefully and with proper supplements. The main difficulty in its use is the problem of storage as its high moisture content is favorable to mold growth.

Corn and Cob Meal. Bulk, one of the essentials in a dairy ration, is the characteristic that makes corn and cob meal a valuable feed. When corn is fed in a finely ground form it is likely to form pasty masses in the

alimentary tract of the cow and consequently it is not only incompletely utilized, but it may also cause digestive disturbances. The fine particles of cob in the corn and cob meal possess little if any nutritive value, but they have a very beneficial effect. They add bulk to the feed and, by keeping the particles of the corn apart, allow of more complete digestion. Therefore, corn and cobmeal, tho it contains a large amount of indigestible fiber, is nearly as valuable pound for pound in feeding dairy cattle as corn meal.

Corn Bran. Corn bran is now seldom on the market as it is used in the preparation of other feeds, for example gluten feed. It contains more fiber and less protein than wheat bran.

Gluten Meal. Gluten meal is exceedingly rich in crude protein, containing on the average about 35.5 per cent. It is a very heavy feed and likely to cause digestive disturbances unless fed in limited quantities.

Gluten Feed. Gluten feed is fairly high in crude protein, containing on the average about 25 per cent. The addition of corn bran gives it a much higher per cent of crude fiber than gluten meal but the increased bulk adds materially to its usefulness. Where the soluble materials of the steep water have been added the ash content is also good. As a rule gluten feed is a fairly economical source of protein, but being a corn by-product it should not be the only concentrate used to balance a ration containing a large amount of corn.

Germ Oil Meal. This feed contains less protein than gluten feed, but on the average it contains almost 11 per cent of fat.

Hominy Feed. Hominy feed differs very little in composition from corn, tho it contains higher per cents of fiber, fat, and ash. It is essentially a carbohydrate feed which can often be used economically, especially as it is bulkier than corn meal tho rather less digestible.

Corn Distillers' Grains. Distillers' wet grains are too bulky to be profitably shipped far and as their watery nature makes them perishable they are usually dried and sold as distillers' dried grains. They contain about twice as much crude protein and three times as much fat as wheat bran and have a feeding value above that of gluten feed. Being bulky and containing about 31 per cent of crude protein they form an excellent feed.

Oats. Oats vary considerably in quality. In the south they have a large per cent of hull and a light bushel weight, while in the north they are plumper and weigh more per bushel. Oats are higher in crude protein, fiber and ash than corn and almost equal to it in per cent of fat. There is no grain better than oats for milk producing cows or cows about to freshen, but they are frequently too high in price to be fed economically except in limited quantities to high producing cows. It is usually best to grind oats before feeding them to dairy cattle. Not only are they very palatable, but when ground and mixed with the rest of the grain ration they increase its bulk and thus enhance its value.

Oat By-Products. Several by-products, including oat hulls and oat shorts or middlings, are made in the manufacture of oatmeal but they are of little importance in feeding dairy cattle, except as constituents of mixed feeds. Oat hulls contain almost 30 per cent of crude fiber and have little feeding value. They are usually mixed with other feeds and their bulk may then have some beneficial effect. Oat middlings contain more fat than wheat bran. As with oat bran, oat dust and oat clippings, they are usually put into mixed feeds.

Wheat. As wheat is the chief American grain for human consumption and consequently demands a high price, only poor or spoiled lots are available for stock feeding. Wheat contains more protein, ash and carbohydrates than corn but it is lower in fat. Tho higher than corn in protein it is a carbohydrate feed. Damaged wheat as a rule differs little in com-

position from good grain, but often contains more protein. It is about equal to corn for milk production and when used should be ground.

Wheat Bran. The protein content of wheat bran is high, running usually about 16 per cent in crude protein. It has a fair amount of other digestible nutrients, tho it has a relatively high content of crude fiber. The ash content is also high and is rich in phosphates, tho poor in lime. Bran is light and bulky, is extremely palatable and has a beneficial and cooling effect on cows. Owing to its high price it is sometimes not a very economical protein supplement for corn and other carbonaceous feeds. It can seldom be profitably fed to all the animals in a herd, but even tho it is high priced it is usually advisable to feed it to cows just before and after freshening, to animals that are being forced for records and to young stock. Its laxative properties and its palatability render it extremely useful, in the form of mashes, for cows that have gone off feed.

Wheat Middlings. Standard wheat middlings or shorts, tho higher in protein than wheat bran, should seldom be fed to dairy cows. They are not palatable and there are other more economical sources of protein. When fed middlings should be used in small quantities only and mixed with other feeds.

Flour Wheat Middlings. This feed contains less crude fiber and more protein than the standard wheat middlings. Like shorts they should be fed in limited quantities, if at all.

Red Dog Flour. This contains less fiber and ash and more nitrogen-free extract than wheat bran. In feeding value it is very similar to good flour middlings.

Barley. Barley is a common feed where corn cannot be grown successfully, and is excellent in value. It is rather higher in crude protein and fiber, and lower in fat, than corn and its nutritive value is just a little less. When fed it should be rolled instead of being ground, as barley meal is likely to cause indigestion. Being carbonaceous, it requires to be supplemented with protein feeds. It is palatable and when it can be obtained at a reasonable price makes a valuable addition to the ration of the dairy cow.

Barley Shorts and Barley Bran. These products contain less protein than the corresponding wheat products and are of little importance in dairy cattle feeding.

Malt Sprouts. The dried sprouts from the malted barley grains contain about 26 per cent of crude protein. This is fairly easily digested but a large part of it is not true protein. Malt sprouts contain over 12 per cent of crude fiber and the per cent of nitrogen-free-extract and fat is low. They are bulky, but owing to their unpalatable nature not more than two or three pounds per head per day should be fed and they should be soaked in water for several hours before feeding.

Brewers' Wet Grains. Owing to their bulk and to the fact that they should be fed fresh, brewers' wet grains are in common use only near breweries. When properly handled they make a profitable feed for dairy cows, the usual allowance being 20 to 30 lbs. per day. It is very essential that they be fed before decomposition starts, otherwise digestive disturbances are sure to result and the odors from the decomposing feed will also be imparted to the milk.

Brewers' Dried Grains. They form a bulky feed and contain about 10 per cent more crude protein than wheat bran. They have a higher per cent of fiber and fat and a lower per cent of ash than bran. Brewers' dried grains can often be used as a protein supplement and usually are more economical than wheat bran. They add bulk to the ration but they have not the same beneficial laxative and cooling effect on the system as bran.

Rye. Rye is not quite such an efficient feed for milk production as corn. In composition it differs little from wheat, containing slightly less protein, fiber, and fat and a little more ash and nitrogen-free extract. It is not very palatable to dairy cows and large quantities of it are likely to cause digestive disturbances. Two or three pounds per day may be safely fed along with other feeds.

Rye By-products. The chief rye by-products are middlings, bran and distillers' grains. The rye middlings and bran do not differ much from wheat middlings and bran except that they are somewhat lower in fiber, fat and protein and are unpalatable. Rye distillers' grains are considerably lower in protein and fat than those made from corn and are consequently of less value in the feeding of dairy cattle.

Buckwheat and its By-products. Buckwheat and its products are not much used in the feeding of dairy cattle. Buckwheat middlings, containing over 28 per cent of crude protein, make quite a good protein feed but are often mixed with the hulls and sold as buckwheat bran or feed.

Emmer. This feed, also known as spelt, is not common in Iowa and is not as valuable as corn for dairy cows. It contains about 12 per cent of crude protein.

Kafir. This feed, containing about 11 per cent of protein, is of little importance in Iowa. As it is constipating it should be fed along with laxative feeds.

Milo. Milo is very similar to kafir in composition but it has a laxative rather than a constipating effect.

Rice and its By-products. Damaged rice, both rough and hulled, is sometimes fed to cattle but the quantity available is small. Rice hulls should never be fed to cattle, for not only are they very fibrous and practically lacking in digestible nutrients, but they contain a large per cent of sandy material which causes great irritation in the digestive tract and may even result in death. Rice bran, when of high grade, contains about 12 per cent crude protein and 11 per cent fat, but it is not considered a good feed for milch cows as it is likely to become rancid and is said to spoil the flavor of the milk even when fed fresh. Rice polish is little used in feeding.

Flaxseed. This is used in the feeding of calves but not of cows.

Linseed Oil Meal. New process oil meal contains less fat than the old process. Owing to difference in values, new process oil meal is sometimes substituted for old process, but the following simple test will enable any one to distinguish between them: Put a little of the finely pulverized meal in a glass and to it add ten times its volume of boiling water. Stir thoroly and allow to stand undisturbed for an hour. If the meal settles to the bottom and leaves the water clear, it is new process; if the mixture remains jelly-like, it is old process. Linseed oil meal is one of the best feeds for dairy cows. It contains a large amount of digestible nutrients and has a laxative and cooling effect upon the system. It is a very safe feed, and tho its high price frequently makes it a less profitable source of protein than some other feeds, it is often advisable to use it, for animals that are off feed, in low condition, or being prepared for freshening or Advanced Registry tests. One or two pounds per day makes an excellent addition to a ration. The old process oil meal contains 3 per cent less crude protein and 4½ per cent more fat than the new process; it is also more digestible and has a better effect on the system, and so should be fed instead of the new process if the difference in price is not too great.

Cottonseed. Very little whole cottonseed is now fed to cattle as nearly all of it is used in the manufacture of oil.

Cottonseed Hulls. These are extremely high in fiber and very low in digestible nutrients. They should not be bought for a dairy feed, tho they are sometimes used as a filler in cottonseed feeds.

Cottonseed Meal. This is one of the richest and most nitrogenous feeds available and is often an economical source of protein. Cottonseed meal is sold according to the following grades: choice, prime, and good. Besides being rich in protein, cottonseed meal contains a relatively large amount of fat and ash which also add to its value. It has a constipating effect and so should be fed with such laxative feeds as linseed oil meal and bran. Cottonseed meal should always be bought subject to guarantee as it varies greatly in protein content. It should be in good fresh condition as moldy meal is not only unpalatable but also dangerous to stock. Under certain conditions any grade of cottonseed meal may prove poisonous and it should never be fed to young calves or to cows about to freshen. However, there is no danger in feeding a limited amount, two or three pounds per day, to milking cows, provided it is mixed with laxative, bulky and less nitrogenous feeds. It is an excellent feed for cows on pasture, as its constipating effect counteracts the effect of washy grass. Unlike oil meal, it serves to harden butter which is oftentimes soft during the summer time.

Cold-pressed Cottonseed Cake. This feed contains more fiber than cottonseed meal, due to a larger per cent of hulls, and it is consequently less valuable as a feed. It is usually sold as broken cake but sometimes it is ground into a meal. It is also put on the market under various trade names.

Canada Field Peas. Field peas contain about 23 per cent of crude protein and make an excellent supplement to corn.

Cowpeas. These are very similar in composition to field peas. There is not a large acreage of this crop in the corn belt and the bulk of it is used for silage and hay.

Soybeans. Of the leguminous seeds used in cattle feeding, this is the richest in crude protein and ash. The residue left after the extraction of the oil from the beans is sold as soybean cake or meal and used for feeding. The extracted soybean meal has about 41 per cent of crude protein and 7 per cent fat, or in other words 5 per cent more protein and 10 per cent less fat than there is in the soybeans. These are excellent feeds for dairy cows, tho they tend to produce a soft butter. An abundance of carbohydrate feeds should be fed with them.

Molasses. Molasses, whether from sugar cane or sugar beets, is a valuable carbonaceous feed. The two varieties do not differ much in composition, tho the beet molasses is likely to have a purgative action due to the alkaline salts present. The protein in molasses has little nutritive value. Owing to its high price molasses is often not an economical feed. However, it is often valuable as an addition to feeds of poor quality, such as badly weathered hay or musty grain. The molasses, either alone or diluted with water, is poured over the other feeds. Not more than two or three pounds per cow per day should be fed. Animals well along in pregnancy should receive molasses only in limited amounts, if at all.

Proprietary Feeds. Many proprietary feeds are on the market, both mixed feeds and standard feeding stuffs which are sold under trade names. A number of these are valuable while others have nothing to recommend them but their name and appetizing odor. Proprietary feeds should be bought according to their composition and their digestibility. The protein content of these feeds is usually fairly high, but the price asked for them is frequently much too high.

Roughages

The roughages used in the feeding of dairy cattle should as a rule be grown on the farm. There is no more economical way of marketing the hays and other roughages grown on the farm than by way of the dairy cow, provided they are suitable for dairy cattle. The roughages can be classed as succulent including pasture, roots, silage and soiling crops; and dry forages, such as hays, fodder and stover.

SUCCULENT ROUGHAGES

No feeds will induce greater or more economical milk production than succulent ones and it is essential that a supply of these be on hand thruout the year. With a judicious combination of pasture, soiling crops and silage this can be obtained.

PASTURE

Good succulent pasture is the feed, par excellence, for the dairy cow. It is not only bulky and succulent, but it contains the necessary food nutrients in about the correct proportions. The pasturing season in Iowa usually lasts from May to October. For the first six weeks or two months no additional rough feed will be required and during the early part of the season, it is well to cut down, and in most cases to eliminate entirely the grain ration of all except the heaviest producers. This cools and rests the digestive tract and the cow is in much better shape to handle concentrates when it again becomes necessary to feed them. From the time pasture begins to dry up, as a rule about the middle or end of June, until the end of the pasturing season, it is well to feed soiling crops or silage and some concentrates. By the use of soiling or silage not only will the milk production per cow be increased, but the carrying capacity of the farm can also be considerably increased. Bluegrass makes an excellent pasture while it lasts, but its period of greatest usefulness is usually short. For a good cow pasture nothing equals a mixture of grasses and clovers, as the variety increases palatability, the clovers increase the protein content, and the clovers and mixed grasses supply excellent feed after the bluegrass season is past.

If pasture is used without soiling or summer silage it will require one and one-half to two and one-half acres per cow to get the best results, whereas if silage or soiling is fed the pasturage allowance can be economically cut down to as low as one-half an acre per cow. The carrying capacity and returns from a pasture are greatly influenced by the method in which it is handled. It should be well drained and regularly manured. The stock should not be turned on to it in spring until the land is fully dry and growth is well started. Stocking the pasture before there is a good cover lessens the vitality of the forage, and trampling on wet ground does much damage. Over stocking at any time is also inadvisable. Weeds detract from the value of a pasture and should be kept down at all times.

SILAGE

Corn silage is essential on all dairy farms in the corn belt. Without it the largest and most economical milk production cannot be obtained. Corn being a succulent plant which is easily harvested and put thru the cutter makes an excellent silage crop.

That the use of the silo makes possible the most efficient harvesting of the corn crop is shown by the following figures from the Wisconsin Agricultural Experiment Station. During four years' work there it was found that when the corn crop was dried in the shock there was an average loss of 23.8 per cent of the dry matter and 24.3 per cent of the crude protein, whereas when the corn was made into ensilage the respective losses were 15.6 per cent and 16.8 per cent. This shows a considerable conservation of the valuable food nutrients. Then again, when the crop has been put in the silo all of it will be consumed by the animals, whereas when the corn has been shocked the stock will refuse a large portion of it.

The stage of ripeness at which the crop is cut has a great influence on the yield and quality of silage produced. If the ensiling is done too early the largest yield of nutrients will not be obtained. Also, owing to the large per cent of water and soluble substances present, the fermentation will be excessive, much valuable feeding material will be lost, a poor quality of silage will result, and the silo may leak. If the cutting is deayed too long, the yield of dry matter will be largest, but owing to the large amount of air present the contents of the silo will become moldy and perhaps rot unless water is added at the time of filling. Moldy silage is not only undesirable but is sometimes dangerous to the stock.

The best silage is produced when the corn is cut just as the kernels are well dented. At this stage the yield of dry matter is large and there is still usually sufficient moisture present to insure thoro packing and a succulent, palatable silage.

The following figures, adapted from "The Soft Corn Predicament," by Evvard of the Iowa Agricultural Experiment Station, illustrate well the facts mentioned above.

TABLE I. YIELD OF FOOD NUTRIENTS IN CORN AT DIFFERENT STAGES OF GROWTH (TAKEN ON ACRE BASIS) MATURE YIELD TAKEN AS 100

Stage of Growth	Dry Matter	Crude Protein	Nitrogen Free Extract	Crude Fiber
In the milk	66	79	61	78
In the glaze	86	82	86	88
Well dented	95	95	96	92
Ready to shock	100	100	100	100

Tho good succulent corn is best for silage, fairly satisfactory silage can be made from a corn crop damaged by drought or frost which otherwise would be largely wasted. Such material is not necessarily poor or dangerous as a feed. It contains the same amount of nutrients as it did immediately before it was damaged, tho of course less than if it had been allowed to come to the proper stage of development. If it is ensiled as

soon as possible after it is damaged it will come out of the silo in the spring in good condition. If allowed to dry out, however, add water, as the corn is being put into the silo to assist in its packing and to impart the necessary succulence. Corn fodder that has been dried in the shock can also be made into good silage if plenty of water is added. Tho not just as palatable as the silage made from the fresh green forage, it gives good results and will be more thoroly utilized than would the dry fodder. Similarly, corn stover can be made more valuable as a feed by being put in the silo, tho of course the absence of the ears lowers its feeding value.

The value of corn silage is due largely to its succulence, bulk and palatability and to its beneficial effect on the digestive tract of the animal. In effect it is laxative and cooling. These are the essential characteristics of a good ration for a dairy cow and they make silage an excellent feed for milk production. When cows are turned out to pasture in the spring the milk yield invariably increases, due largely to the palatable, succulent nature of the pasture. This initial rise is not a full measure of the value of pasture, however, for it also puts the cows in a condition for continued milk production. The feeding of silage in winter gives many of the advantages of pasture as the essential characteristics of the two are very similar.

Silage, tho of greater value in winter, can be used to considerable advantage in summer when the pasture is short and dry. The feeding of silage in the barn during the hot dry weather of July and August not only supplements the rather scant pasture, but also allows the cows to feed in a cool place where they can be sprayed to keep off the flies.

Tho feeding silage is not a difficult matter, it should be done with care or trouble may arise. The silo should be of such a diameter that enough feed will be taken out each day to prevent decomposition of the top layer. This is especially important in the summer, so if a silo is erected for summer use only it should be of smaller diameter than the winter silo. In winter the silage will keep well if at least two inches per day are removed for feeding purposes.

The following table shows the number of cows that can be kept during the winter with various sized silos. The length of the silage feeding period is taken as 225 days and average amount of silage fed as 30 lbs. per day. The heights given are the heights of the silos from the bottom of the pit to the eaves. The depth of the silage will be about six feet less than this, depending on the amount of settling. With large herds it will usually be found best to build two silos of small diameter rather than one of large diameter. For this reason data is given in table II on quite a few silos of small diameter. As a rule it is well to have the total depth of the silage not less than 36 to 38 feet. If it is less than this and has to be fed all winter the amount removed each day for feeding purposes will be a layer less than two inches and the silage may spoil.

At one time it was considered that good milk could not be produced when silage was fed, but this has been found to be incorrect. Milk will rapidly take on a silage odor if it is given the opportunity, but in a well managed

TABLE II. DESIRABLE CAPACITY OF SILO FOR DIFFERENT SIZES OF HERDS

Diameter of Silo Feet	10		12		14		16		18	
Height of Silo Feet	Cap. Tons	No. of Cows	Cap. Tons	No. of Cows	Cap. Tons	No. of Cows	Cap. Tons	No. of Cows	Cap. Tons	No. of Cows
34	42	12	61	18	83	25	-----	-----	-----	-----
36	47	14	67	20	91	27	-----	-----	-----	-----
38	51	15	74	22	100	30	131	39	-----	-----
40	56	17	80	24	109	32	143	42	-----	-----
42	-----	-----	87	26	118	35	155	46	196	58
44	-----	-----	-----	-----	128	38	167	49	212	63
46	-----	-----	-----	-----	-----	-----	180	53	229	68
48	-----	-----	-----	-----	-----	-----	-----	-----	244	72

barn it should not have this opportunity. If the silos are shut off from the barn, the silage fed after milking, the amount limited to what will be cleaned up in a short time, and the milk removed from the barn as soon as it is milked, there is no danger of having a noticeable silage odor in milk. Bad odors of any kind in milk are as a rule due to carelessness.

Even at the present time it is sometimes said that silage causes the teeth of the cows to decay, brings about digestive troubles and may even induce abortion. These statements are incorrect. Silage does not cause teeth to decay and unless it is badly molded or decayed or suddenly fed in too large amounts it will not cause digestive troubles or abortion.

SOILING CROPS

Soiling crops are also excellent for supplementing pasture in summer. With the aid of soiling crops the area of pasture needed for the dairy herd can be reduced, or more animals can be kept, and consequently the cost of milk production lowered. The other advantages are similar to those to be obtained from the feeding of silage during summer, with the addition of variety.

Several crops can be used successfully for soiling and table III gives information concerning those that have been giving satisfaction at the Iowa State College dairy farm during the last six years.

The dates given for sowing and cutting will vary quite a little according to seasons but they form a fairly reliable guide.

The various cuttings of alfalfa can be utilized successfully for soiling, tho the time they can be used is limited. If the cutting is started too early it will decrease the yield and if it is delayed too long the following crop will suffer. The daily amount of green alfalfa consumed by cows is not as great as for some other feeds.

Oats and Canada field peas are among the most valuable early soilings. When the oats are in the milk and the peas have filled the pods, but have not commenced to dry, they form a very palatable and highly nutritious succulence. The main drawback to this mixture is that it ripens rapidly and when ripe is not so palatable. Owing to their early and rapid growth, however, they are well suited for the early part of the dry season.

Amber cane and cowpeas in mixture yield heavily and the season thru

TABLE III. SUCCESSION OF SOILING CROPS

Crop	Approximate Time of Cutting	Approximate Time of Sowing	Rate of Seeding Per Acre	Average Yield of Green Feed Per Acre, Tons	Cost Per Ton Dollars
Alfalfa	June 10-20	Previous Spring or August	20 lbs.	8	3.00
Oats and Canada Field Peas	June 20-July 5	April 5	1½ bushels Oats and 1½ bushels Peas	6	5.00
Oats and Canada Field Peas	July 5-30	April 20	1½ bushels Oats and 1½ bushels Peas	5	5.00
Alfalfa	July 10-20	Previous Spring or August	20 lbs.	4	4.00
Amber Cane and Cowpeas	Aug. 1-30	May 25	35 pounds Cane and 1 bushel Peas	9	2.50
Amber Cane and Cowpeas	Aug. 15-Sept. 5	June 25	35 pounds Cane and 1 bushel Peas	13	2.00
Amber Cane and Cowpeas	Sept. 1-20	July 5	35 pounds Cane and 1 bushel Peas	9	2.00
Sudan Grass	August 25-Sept. 10	May 25	20 lbs.	11	4.00
Soybeans	Aug. 25-Sept. 15	May 20	50 lbs.	6	2.75

* This is the approximate cost of the green feed as it is laid down in the barn, and includes the expenditure for seed, labor and other items in the cost of production.

which they can be used is a long one. The cowpeas increase the protein content of the feed and also add nitrogen to the soil, but in all probability larger and cheaper yields of green feed can be obtained by sowing the cane alone at the rate of about 75 to 80 pounds per acre. Sown in this way the cane will be finer and will not become so woody as ripening progresses.

Sudan grass gives large yields of feed but it is not so palatable as some of the other soiling crops and it becomes fibrous when ripe.

Soybeans have not often been tried as a soilage in the corn belt, but when drilled in at the rate of 50 pounds per acre economical yields are obtainable. For the first few days cows do not care for them much, but they soon acquire a taste.

Millet proves a fairly good soilage for use in the late part of the season and can be sown for use after the crops in the above table have been cut. It can be used up to the time of frost or until the silos are filled. Green corn can also be used until silo filling time, tho it is rather difficult to handle.

The above is only an outline of a soiling system, and it can be varied to suit individual conditions. Tho soiling is not as cheap as summer silage it makes possible a decrease in the cost of summer milk production.

The average cost per cow for pasture and soiling at the Iowa State College dairy farm during the last six years has been practically $8.00 and

if pasture alone had been used the cost would have been somewhere between $9.00 and $15.00.

The choice between summer silage and soiling crops depends largely on individual conditions. On the average farm, if a silo of small diameter is available, summer silage is probably the most economical, especially if help is scarce. Where no silo is available soiling crops should be used, and on large dairy farms more cows can usually be kept by growing soiling crops than by feeding summer silage. For the most efficient and economical milk production one or the other should be used.

Roots. Root crops are not much in evidence in Iowa and are not very important in any part of the corn belt. Pound for pound of dry matter roots have about the same feeding value as corn silage and so owing to the small yields and the high cost of production it seldom pays to grow any large quantity of them. However, where cows are being run on official test and large records are wanted, it is often advisable to have a few roots, as their palatability and succulence will increase the flow of milk. Sugar beets, mangels, and rutabagas are most commonly used. Potatoes might also be put in this class as cows will utilize small potatoes efficiently. Potatoes have to be fed carefully, however, owing to the danger of choking and to the fact that too large quantities of them will produce milk and butter with poor flavor.

Beet Pulp. This is the residue from the manufacture of beet sugar. Wet beet pulp makes an excellent succulence for supplementing or even replacing silage. Owing to its high moisture content it cannot be used economically except close to the sugar factories where the cost of transportation is small. It is usually bought in the dried condition and soaked before feeding. It should be soaked for about 12 hours and will take up about three times its weight of water. It can be fed with the silage, or as a substitute if silage is not available. When fed as the sole succulence, from four to eight pounds per day of the dried material can be given and when fed with silage two to four pounds will as a rule be sufficient.

DRIED ROUGHAGES

The dairy cow is preëminently a consumer of roughages and usually provides the most economical market for those grown on the farm. They supply the bulky and fibrous part of the ration so necessary for the most efficient action of the cow's digestive system.

Corn Fodder and Stover. Corn fodder and stover, tho not so good as silage, make fairly good carbonaceous roughages. Where they have to be fed, some nitrogenous hay should also be used. Where there is silage and also some fodder or stover available it is often advantageous to give the cows a little of the fodder or stover in addition to their silage. They will relish small quantities of it, and a good plan is to give the cows access to it when out for exercise.

Straw. The cereal straws, being poor in protein, low in digestibility and unpalatable, are not good roughages for milch cows.

Timothy Hay. This roughage is too fibrous and poor in protein to make a good cow feed. Its feeding value is about the same as that of oat straw and it should not be fed to milking cows. Usually it can be sold for as high a price as it takes to buy alfalfa hay and in this case the best policy is to sell the timothy and buy alfalfa.

Mixed Hay. Hay from the mixed grasses is better than timothy and if there are some legumes present it makes a fairly satisfactory feed.

Oat and Pea Hay. A mixture of oats and Canada field peas, in equal parts and drilled in at the rate of three bushels per acre, will yield a good hay for dairy cows. The best results are obtained when the crop is cut just as the oats are entering the dough stage. Tho not quite so good as alfalfa or clover hay it makes an excellent substitute.

Alfalfa Hay. This is undoubtedly the best dry roughage for dairy cows. It has a high content of valuable nutrients, especially protein and ash, a good effect upon the system and it is palatable. These properties, in addition to its bulk, render it an excellent material for balancing the silage and corn part of the ration. For best results alfalfa hay should be harvested in good condition. One of the main points to remember in curing alfalfa is that the leaf waste should be kept as low as possible. The leaves are the most nutritious part of the plant and every care should be taken to cure the hay with a minimum of handling, as each time the hay is handled some of the leaves are lost. One of the main functions of alfalfa hay in the ration is to supply protein and tho it can not be used to eliminate the grain ration, the concentrates fed can be rather less nitrogenous when it is used. Similarly, alfalfa meal is a roughage and not a concentrate, consequently it should not be fed as a substitute for the grain ration. If good alfalfa hay is obtainable alfalfa meal should not be used.

Clover Hay. The value of clover hay for milk production is about four-fifths that of alfalfa hay. Except that it contains rather less protein than alfalfa it is very similar and the statements regarding alfalfa apply also to clover hay.

Sweet Clover Hay. Not much has been done with sweet clover so far but it is probably about equal in value to alfalfa hay for feeding purposes. Stock usually object to it at the start when it is in the fresh green state. This is probably due to the presence of the bitter principle, cumarin. In the curing of hay this objectionable substance is perhaps destroyed to some extent and the hay is consequently more palatable than is the green feed.

REQUIREMENTS OF A DAIRY RATION

The main object in feeding cows is to get the largest and most economical milk production. To do this it is necessary to know how to compound a ration. This is not a very difficult proposition when the composition, properties and prices of the various feeds available are known. In compound-

ing a ration the following points must be considered: palatability, variety, bulk, succulence, effect upon the system, balance of nutrients and economy.

PALATABILITY

Palatability is one of the most important points to consider in formulating a ration for dairy cows. If the feed is not palatable the cow will not eat as much as she really requires and consequently will lose weight or decrease in milk flow, or both. Unpalatable feeds will often throw cows off feed. Moldy or damaged grain and badly weathered hay are unpalatable. Certain feeds are naturally unpalatable and they should be fed only in limited amounts and mixed with other feeds. Some cows have distastes for certain feeds and where the highest production is aimed at, the tastes of each cow should be catered to by individual feeding. The preparation of the feed has in some cases quite an influence on its palatability, for instance cracked corn, and ground oats are more palatable than the whole grains.

VARIETY

Frequent changes in the ration are not conducive to the best work on the part of the cow and as she soon tires of a ration consisting of only two or three feeds it is well to have a variety of feeds in the ration. It is best to feed at least two varieties of roughage, the first choice going to corn silage and alfalfa hay, and the grain ration should also contain a variety of ingredients. A mixed ration like this is much more palatable than is a simple one.

It has lately been found that the value of a feed depends not entirely on its content of digestible protein and other nutrients, but also on the presence of certain substances which are but little understood, and are deficient in some feeds. By giving a variety of feeds the presence of these essential constituents, or "vitamines," is practically assured. It has also been found that all proteins are not of like value in feeding and that sometimes a mixture of two proteins is more efficient than either of the two alone. This is another argument in favor of variety in the ration. The dairy cow, unlike the beef steer, is fed for successive long periods and so must have a varied ration.

BULK

Unlike the hog, the cow has a large roomy digestive tract that is built for the handling of rough feeds. The cow digests her feed to best advantage when her ration is bulky as the bulky parts of the feed keep the small particles of grain apart and thus allows them to be thoroly acted on by the digestive juices. The hay and silage should not constitute all the bulk of the ration as part of it can profitably be supplied by such feeds as corn and cob meal, ground oats, wheat bran and distillers' dried grains.

SUCCULENCE

A succulent ration has many beneficial effects. It supplies part of the large amount of water required by milking cows, increases the palatability

of the ration, and has a laxative and cooling effect on the cow's digestive system. In the early part of the summer, pasture grass provides the necessary succulence but in the later part of the season it should be supplemented with corn silage or soiling crops; in winter silage is the most economical succulence in Iowa, tho it can sometimes be advantageously supplemented with beet pulp or roots.

EFFECT UPON DIGESTIVE SYSTEM

The effects of feeds on the digestive system of the cow vary considerably. If a ration is to give best results it should be cooling and have a slightly laxative effect. Succulent feeds in sufficient quantity have beneficial effects, but it is well, especially where a large amount of grain is being fed, to see that the constipating and heating effect of feeds like cottonseed meal is neutralized by feeding cooling ones like wheat bran and oil meal.

BALANCE OF NUTRIENTS

For the best production a cow must be supplied with sufficient digestible food nutrients—protein, carbohydrate fat and ash. A large amount of nutrients in the feed is not all that is required, however, as the relative proportions or balance of the nutrients should be right. For example, a liberal ration will not give the best production if it is deficient in protein and contains too many carbohydrates and fats. Similarly, a ration that is liberal but has too much protein will usually be uneconomical.

This problem of balance of nutrients has received much attention and feeding standards have been proposed by several investigators in this country and abroad. In this circular the Armsby-Eckles standard will be used. This standard is based on the protein and energy requirements of the animal. The protein used is digestible true protein and needs no further explanation. It is based on digestible protein because feeds vary not only in their protein content but also in the digestibility of the protein. Hence substances supplying equal amounts of protein do not necessarily supply equal amounts of digestible protein.

The energy requirements are much simpler to use as a standard than the carbohydrate and fat requirements, and are probably more accurate. When substances are burned they supply definite amounts of heat, and when used for heat production in the animal body they supply similar amounts of heat. The food substances can be used in the body for the production of forms of energy other than heat, but their heat producing power is a convenient standard of comparison. The therm, or unit of heat measurement, is the amount of heat required to raise the temperature of 1,000 lbs. of water about 4° F.

According to the Armsby standard the maintenance requirements of a 1,000 lb. animal are .5 lbs. digestible protein and 6 therms net energy value per day. As the maintenance requirements of cattle are figured proportional to their live weight, the requirement for any animal can be calculated from the above standard if its weight is known.

TABLE IV. NUTRIENTS IN 100 LBS. OF SOME COMMON FEEDS*

Feed	Total Dry Matter	Digestible Nutrients				
		Crude Protein	Carbohydrate	Fat	Total	Total Ash
Concentrates						
Corn, Whole	89.5	7.5	67.8	4.6	85.7	1.5
Corn, Soft	69.4	5.5	53.3	3.5	66.7	1.0
Corn Meal	88.7	6.9	69.0	3.5	83.8	1.3
Corn and Cob Meal	89.6	6.1	63.7	3.7	78.1	1.5
Hominy Feed	89.9	7.0	61.2	7.3	84.6	2.6
Gluten Meal	90.9	30.2	43.9	4.4	84.0	1.1
Gluten Feed	91.3	21.6	51.9	3.2	80.7	2.1
Germ Oil Meal	91.1	16.5	42.6	10.4	82.5	2.7
Corn Bran	90.0	5.8	56.9	4.6	73.1	2.4
Distillers' Dried Grains, Corn	93.4	22.4	40.4	11.6	88.9	2.6
Wheat	89.8	9.2	67.5	1.5	80.1	1.9
Red Dog Flour	88.9	14.8	56.5	3.5	79.2	2.5
Wheat Shorts	89.6	13.4	46.2	4.3	69.3	4.4
Wheat Bran	89.9	12.5	41.6	3.0	60.9	6.3
Rye	90.6	9.9	68.4	1.2	81.0	2.0
Ground Oats	89.2	9.4	51.4	4.1	70.0	3.3
Barley	90.7	9.0	66.8	1.6	79.4	2.7
Brewers' Dried Grains	92.5	21.5	30.5	6.1	65.7	3.5
Buckwheat	87.9	8.1	49.7	2.5	63.4	2.1
Emmer (Spelt)	91.3	9.5	63.2	1.7	76.5	3.7
Cottonseed Meal	92.5	37.0	21.8	8.6	78.2	6.2
Cold-pressed Cottonseed Cake	92.1	21.1	33.2	7.4	70.9	4.2
Linseed Oil Meal O. P.	90.9	30.2	32.6	6.7	77.9	5.4
Linseed Oil Meal N. P.	90.4	31.7	37.9	2.8	75.9	5.6
Cowpea	88.4	19.4	54.5	1.1	76.4	3.4
Field Pea	90.8	19.0	55.8	.6	76.2	3.4
Soybean	90.1	30.7	22.8	14.4	85.9	5.3
Cane Molasses	74.2	1.0	58.2	-----	59.2	6.4
Dry Roughages						
Corn Fodder	81.7	3.0	47.3	1.5	53.7	5.0
Corn Stover	81.0	2.1	42.4	.7	46.1	5.5
Oat Straw	88.5	1.0	42.6	.9	45.6	5.4
Rye Straw	92.9	.7	39.6	.4	41.2	7.1
Wheat Straw	91.6	.7	35.1	.5	36.9	8.4
Millet Hay	85.7	5.0	46.0	1.8	55.0	6.3
Mixed Grass Hay	87.2	4.3	44.3	1.2	51.3	5.6
Prairie Hay	93.5	4.0	41.4	1.1	47.9	7.7
Timothy Hay	88.4	3.0	42.8	1.2	48.5	4.9
Oat Hay	88.0	4.5	38.1	1.7	46.4	6.8
Clover and Timothy Hay	87.8	4.0	39.7	1.1	46.2	6.1
Oat and Pea Hay	83.4	8.3	37.1	1.5	48.8	7.3
Alfalfa Hay	91.4	10.6	39.0	.9	51.6	8.6
Red Clover Hay	87.1	7.6	39.3	1.8	50.9	7.1
Sweet Clover Hay	91.4	10.9	38.2	.7	50.7	7.2
Cowpea Hay	90.3	13.1	33.7	1.0	49.0	11.9
Soybean Hay	91.4	11.7	39.2	1.2	53.6	8.6
Dry Beet Pulp	91.8	4.6	65.2	.8	71.6	3.5
Succulent Feeds						
Bluegrass	31.6	2.3	14.8	.6	18.5	2.8
Timothy	37.5	1.5	19.3	.6	22.2	2.2
Corn Fodder	21.9	1.0	12.8	.4	14.7	1.2
Corn Stover	22.7	.5	12.0	.2	12.9	1.4
Alfalfa	25.3	3.3	10.4	.4	14.6	2.4
Red Clover	26.2	2.7	13.0	.6	17.1	2.1
Sweet Clover	24.4	3.3	10.3	.3	14.3	2.1
Cowpea	16.3	2.3	8.0	.3	11.0	2.0
Field Pea	16.6	2.9	7.1	.3	10.7	1.6
Soybean	23.6	3.2	10.2	.5	14.5	2.4
Oats and Peas	22.6	2.4	10.6	.6	14.4	2.0
Sugar Beets	16.4	1.2	12.6	.1	14.0	1.1
Mangels	9.4	.8	6.4	.1	7.4	1.0
Rutabagas	10.9	1.0	7.7	.3	9.4	1.0
Turnips	9.5	1.0	6.0	.2	7.4	.9
Corn Silage from Mature Corn	26.3	1.1	15.0	.7	17.7	1.7
Immature Corn	21.0	1.0	11.4	.4	13.3	1.4
Frosted Corn	25.3	1.2	13.7	.6	16.3	1.8
Field Cured Stover	19.6	.5	9.9	.4	11.3	1.4

* From the extensive tables in Feeds and Feeding, 16th edition, by Henry & Morrison.

TABLE V. DIGESTIBLE TRUE PROTEIN AND NET ENERGY VALUES IN 100 LBS. OF SOME COMMON FEEDS *

(This table is based on the figures in Table VI)

FEED	Digestible True Protein Pounds	Net Energy Value Therms
Concentrates		
Corn, Whole	7.0	89.16
Corn Meal	6.4	88.75
Corn and Cob Meal	5.7	75.80
Hominy Feed	6.5	81.31
Gluten Meal	28.1	84.15
Gluten Feed	20.1	80.72
Germ Oil Meal	14.3	83.88
Distillers' Dried Grains (Corn)	18.3	85.08
Wheat	8.1	91.41
Wheat Shorts	12.0	59.10
Wheat Bran	10.8	53.00
Rye	9.0	93.71
Oats	8.7	67.56
Barley	8.3	89.94
Brewers' Dried Grains	20.2	53.38
Buckwheat	7.2	59.73
Cottonseed Meal	35.4	93.46
Linseed Oil Meal, O. P.	28.5	88.91
Linseed Oil Meal, N. P.	30.9	85.12
Cowpea	16.9	79.46
Field Pea	16.6	78.72
Soybean	27.3	81.29
Cane Molasses	----	55.38
Dry Roughages		
Corn Fodder	2.3	43.94
Corn Stover	1.6	31.62
Oat Straw	.8	34.81
Rye Straw	.5	17.59
Wheat Straw	.3	7.22
Millet Hay	3.9	47.96
Timothy Hay	2.2	43.02
Oat Hay	3.9	32.25
Clover and Timothy Hay	3.2	41.07
Alfalfa Hay	7.1	34.23
Red Clover Hay	4.9	38.68
Sweet Clover Hay	6.7	38.98
Cowpea Hay	9.2	37.59
Soybean Hay	8.8	44.03
Dry Beet Pulp	.7	75.87
Succulent Feeds		
Bluegrass	2.2	17.77
Timothy	1.1	18.36
Corn Fodder	.8	14.60
Alfalfa	1.8	11.50
Red Clover	1.7	15.87
Cowpea	1.7	10.42
Field Pea	2.1	9.78
Soybean	2.4	12.53
Sugar Beets	.4	11.20
Mangels	.1	5.68
Rutabagas	.3	8.46
Turnips	.4	6.16
Corn Silage from Mature Corn	.6	15.90
Immature Corn	.4	11.96
Frosted Corn	.6	14.27
Field Cured Stover	.3	8.98

* Net Energy values for Ruminants, Bul. 142 Pa. Sta. Armsby & Fries.

The requirements for milk production depend on the quantity of milk produced and on the richness of the milk, as rich milk requires more nutrients than poor milk. Furthermore, each additional pound of milk requires more nutrients for its production than the previous pound. A cow producing 40 lbs. of 3 per cent milk will require rather more than twice as much nutrient material, over and above maintenance requirement, for production than does a cow producing 20 lbs. of 3 per cent milk. The following is the Eckles standard for production.

TABLE VI. PROTEIN AND ENERGY REQUIREMENTS FOR PRODUCTION

	Per Pound of Milk	
Fat Content of Milk %	Digestible Protein Lbs.	Energy Value Therms.
3.0	.050	.26
3.5	.052	.28
4.0	.055	.30
4.5	.058	.33
5.0	.062	.36
5.5	.066	.40
6.0	.070	.45
6.5	.075	.50

It is not always convenient to take into consideration the richness of the milk of each individual in the herd so Eckles suggests that in such cases the following standards be used.

TABLE VII. PRODUCTION REQUIREMENTS BY BREEDS

	Per Pound of Milk	
Breed	Digestible Protein lbs.	Energy Value Therms.
Holstein	.050	.26–.28
Ayrshire	.055	.28–.30
Jersey and Guernsey	.066	.40–.45

Owing to variations in individual requirements, these standards can not be rigidly adhered to and it is also better as a rule to feed rather more than the minimum requirements, especially of protein, as a little excess seems to have a stimulating effect on production. However, these standards are an excellent guide in the feeding of animals.

As a sample of a ration made up according to the above standard take the case of a 1,200 lb. Holstein cow giving 40 lbs. of 3 per cent milk per day. The requirements for this animal will be:

	Digestible Protein lbs.	Energy Value Therms.
Maintenance	.6	7.2
Production	2.0	10.4
	2.6	17.6

For the roughage part of the ration a reasonable allowance would be 36 lbs. of silage and 12 lbs. of alfalfa hay. These feeds will provide the following: (See table V)

	Digestible Protein lbs.	Energy Value Therms.
36 lbs. silage.....	.22	5.72
12 lbs. Alfalfa Hay.....	.85	4.11
	1.07	9.83

This leaves 1.53 lbs. digestible protein and 7.77 therms energy value to be furnished by the grain ration. A grain mixture can be worked out which will supply this deficiency, for instance:

	Digestible Protein lbs.	Energy Value Therms.
3 lbs. Corn and Cob Meal...	.17	2.27
2 lbs. Wheat Bran.....	.22	1.06
2 lbs. Ground Oats.....	.17	1.35
2 lbs. Cottonseed Meal.....	.70	1.86
2 lbs. Distillers' Dried Grains	.22	1.12
	1.48	7.76

This is as close to the standard as it is necessary to calculate for practical purposes.

ECONOMY

In feeding for milk production the chief objective is economy. A large yield of milk and butter fat is as a rule not desirable unless it leaves a greater profit than does a poorer production. In the case where large records are wanted, chiefly for advertising purposes, this does not hold true, however.

In Iowa and other corn belt states, where large quantities of corn and other carbonaceous feeds are grown on the farm and nitrogenous concentrates are the chief feeds that have to be purchased, the cost of protein requires greatest attention. As the carbohydrate equivalents of all concentrates are about equal in value for feeding purposes, the cost of the protein in a feed should be worked out before purchasing, and, other things being equal, the feed that forms the cheapest source of protein should be purchased. The following method is a convenient one for doing this.

Allow one cent for each pound of digestible carbohydrate equivalent in 100 pounds of feed. Subtract this from the cost of 100 pounds of feed. Divide the difference by the pounds of digestible protein in 100 pounds of feed, multiply by 100, and the result will be the cost of 100 lbs. of digestible protein.

For example, which is the cheaper source of protein, wheat bran at $24.00 per ton, or old process linseed oil meal at $35.00 per ton if the bran contains 12.5 per cent digestible protein and 48.4 per cent digestible carbohydrate equivalent, and the oil meal 30.2 per cent digestible protein and 47.7 per cent digestible carbohydrate equivalent?

Wheat Bran

Cost per ton $24.00. Cost per 100 lbs.....$1.20
Cost of carbohydrate equivalent at 1c per lb..... .48

Cost of 12.5 lbs. protein..... .72
Cost of 100 lbs. protein (digestible)..... 5.76

Oil Meal

Cost per ton $36.00. Cost per 100 lbs.....$1.80
Cost of carbohydrate equivalent at 1c per lb..... .48
Cost of 30.2 lbs. protein..... 1.32
Cost of 100 lbs. protein (digestible)..... 4.37

The oil meal is evidently the cheaper source of digestible protein. Table VIII gives the cost per 100 pounds of digestible protein in some common feeds at a wide range of prices.

FEEDING DAIRY ANIMALS

THE CALF

For the best success in dairying the herd should be built up from animals reared on the farm. In this way heifers from ancestry of known productive capacity are obtained and every care can be given to their development. Calf rearing is a problem worthy of separate treatment but brief attention will be given here to the feeding of the young calf.

There is some difference of opinion as to whether or not the new born calf should be allowed to remain with its dam. It is probably best, however, to leave it with its dam for two or three days. This allows the calf to obtain the first milk or colostrum which is so necessary for its well being. The colostrum has a laxative action and aids in getting the digestive tract into good working order. The colostrum can be milked and fed to the calf, but the calf will do better if it is with the dam as it is then able to get the milk warm and at short intervals. The sucking of the calf also aids in relieving any inflammatory condition there may be in the cow's udder at this time.

When the calf is two or three days old it can be taken away from the dam and fed fresh, warm, whole milk in a clean bucket at the rate of 2 to 4 pounds three times a day, depending on the size and vigor of the calf. When the calf is about three weeks old the feeding can be done twice a day and the substitution of skimmed for whole milk can be started. This substitution should take place slowly until the calf is six or seven weeks old when it should be getting an allowance of 12 to 16 pounds of warm skimmed milk per day. The allowance of milk should not be increased too rapidly as over feeding will cause digestive troubles. Similarly the milk should be fed in clean buckets and as soon after milking as possible so that it will still be warm. When on full feed, 16 or 18 pounds of milk will be found about sufficient for a calf. The skim milk feeding should be continued till the calf is seven or eight months old.

Calves will begin taking a little grain even when but a few weeks old and an excellent grain mixture for them is one of equal parts of corn, bran, and oats with small quantities of oil meal. Cracked corn should be fed at first and later shelled corn may be substituted. There is some difference of opinion as to whether whole or ground oats should be used.

TABLE VIII. COST PER 100 IBS. OF DIGESTIBLE PROTEIN IN CONCENTRATES AT VARIOUS PRICES

COST PER TON	$23	$24	$25	$26	$27	$28	$29	$30	$31	$32	$33	$34	$35	$36	$37	$38	$39	$40	$41	$42
FEEDS	COST PER 100 LBS. DIGESTIBLE PROTEIN IN DOLLARS AND CENTS																			
Corn, Whole	4.91	5.57	6.24	6.91	7.57	8.24	8.91	9.57	10.24	10.91	11.57	12.24	12.91	13.57	14.24	14.91	15.57	16.24	16.91	17.57
Corn Meal	5.52	6.25	6.97	7.70	8.42	9.14	9.87	10.59	11.32	12.04	12.77	13.49	14.22	14.94	15.67	16.39	17.12	17.84	18.57	19.29
Corn and Cob Meal	7.05	7.87	8.69	9.51	10.33	11.15	11.97	12.79	13.61	14.43	15.25	16.07	16.89	17.70	18.52	19.34	20.16	20.98	21.80	22.29
Hominy Feed	5.34	6.06	6.77	7.49	8.20	8.91	9.63	10.34	11.06	11.77	12.49	13.20	13.91	14.63	15.34	16.06	16.77	17.49	18.20	18.91
Gluten Feed	2.59	2.82	3.05	3.28	3.51	3.75	3.98	4.21	4.44	4.67	4.90	5.13	5.37	5.60	5.83	6.06	6.29	6.52	6.75	6.99
Gluten Meal	2.03	2.19	2.36	2.52	2.69	2.85	3.02	3.19	3.35	3.52	3.68	3.85	4.01	4.18	4.34	4.51	4.68	4.84	5.01	5.17
Germ Oil Meal	2.97	3.27	3.58	3.88	4.18	4.48	4.79	5.09	5.39	5.70	6.00	6.30	6.61	6.91	7.21	7.52	7.82	8.12	8.42	8.73
Red Dog Flour	3.42	3.76	4.09	4.43	4.77	5.11	5.45	5.78	6.12	6.46	6.80	7.14	7.47	7.81	8.15	8.49	8.82	9.16	9.50	9.84
Wheat Shorts	4.41	4.78	5.16	5.53	5.90	6.28	6.65	7.02	7.40	7.77	8.14	8.51	8.89	9.26	9.63	10.01	10.38	10.75	11.13	11.50
Wheat Bran	5.33	5.73	6.13	6.53	6.93	7.33	7.73	8.13	8.53	8.93	9.33	9.73	10.13	10.53	10.93	11.33	11.73	12.13	12.53	12.93
Oats, Whole	5.60	6.11	6.63	7.14	7.66	8.18	8.69	9.21	9.72	10.24	10.75	11.27	11.78	12.30	12.81	13.33	13.85	14.36	14.88	15.39
Oats, Ground	5.79	6.32	6.85	7.38	7.91	8.45	8.89	9.51	10.04	10.57	11.11	11.64	12.17	12.70	13.23	13.77	14.30	14.83	15.36	15.89
Barley	4.96	5.51	6.07	6.62	7.18	7.73	8.29	8.84	9.40	9.96	10.51	11.07	11.62	12.18	12.73	13.29	13.84	14.40	14.96	15.51
Malt Sprouts	3.19	3.43	3.68	3.93	4.17	4.42	4.67	4.91	5.16	5.40	5.65	5.90	6.14	6.39	6.64	6.88	7.13	7.37	7.62	7.87
Brewers' Dried Grains	3.29	3.53	3.76	3.99	4.22	4.46	4.69	4.92	5.15	5.39	5.62	5.85	6.08	6.32	6.55	6.78	7.01	7.25	7.48	7.71
Cottonseed Meal	1.99	2.13	2.26	2.40	2.54	2.67	2.81	2.94	3.08	3.21	3.35	3.48	3.62	3.75	3.89	4.02	4.16	4.29	4.43	4.56
Cold-pressed Cottonseed Cake	3.09	3.33	3.56	3.80	4.04	4.27	4.51	4.75	4.99	5.22	5.46	5.70	5.93	6.17	6.41	6.64	6.88	7.12	7.36	7.59
Linseed Oil Meal (O. P.)	2.23	2.39	2.56	2.73	2.89	3.06	3.22	3.39	3.55	3.72	3.88	4.05	4.22	4.38	4.55	4.71	4.88	5.04	5.21	5.37
Cowpea	2.99	3.25	3.51	3.76	4.02	4.28	4.54	4.79	5.05	5.31	5.57	5.82	6.08	6.34	6.60	6.86	7.11	7.37	7.63	7.89
Field Pea	3.04	3.31	3.57	3.83	4.09	4.36	4.62	4.88	5.15	5.41	5.67	5.94	6.20	6.46	6.73	6.99	7.25	7.52	7.78	8.04
Soybean	1.95	2.11	2.27	2.44	2.60	2.76	2.93	3.09	3.25	3.41	3.58	3.74	3.90	4.07	4.23	4.39	4.55	4.72	4.88	5.04
Distillers' Dried Grains (Corn)	2.17	2.39	2.61	2.83	3.06	3.28	3.50	3.73	3.95	4.17	4.40	4.62	4.84	5.07	5.29	5.51	5.74	5.96	6.18	6.41
Distillers' Dried Grains (Rye)	4.57	4.94	5.31	5.68	6.04	6.41	6.78	7.15	7.51	7.88	8.25	8.62	8.99	9.35	9.72	10.09	10.46	10.82	11.19	11.56

Alfalfa hay should not be fed alone to young calves as it is too rich for them and is likely to cause kidney and digestive troubles. Clover hay, or a mixture of clover and alfalfa, is better than alfalfa alone.

Calves that are dropped in the fall and winter should be allowed good pasture the following summer and if provided with shade and a little grain will do well. Those that are dropped in the late spring or summer will do better if properly cared for in the barn, at least until there is cool weather in the fall.

THE GROWING HEIFER

If fall calves have been properly treated during the winter it is not difficult to carry them thru the summer. They should be on pasture as much as possible and in addition receive a little grain. The ration can consist of the same constituents as were used earlier, but the corn and oats should be increased at the expense of the oil meal and bran. Ample shade is necessary. When cold weather comes a shed should be available for the heifers.

As the main object in feeding dairy heifers is to produce animals with plenty of constitution and capacity let the feed be bulky and at the same time contain plenty of protein and ash. The protein and ash aid in the building of muscle and bone and bulky feeds distend and develop the digestive organs. Alfalfa and clover hays are excellent roughages to feed to dairy heifers and silage is useful in limited amounts. Where silage is available, 15 to 20 pounds of it may be fed per day to dairy heifers during the winter and this, with 7 or 8 pounds of alfalfa or clover hay and 2 to 3 pounds of grain, makes a good ration. Where silage is not available the amount of hay can be doubled and another pound of grain fed.

Spring or summer calves are not so easily cared for during the winter as are calves of the previous fall, but should be fed very similarly, tho the amount of silage allowed should be limited. During the following summer the heifers will need little but pasture until fall when the treatment may be similar to that of the previous season.

THE DRY COW

Every dairy cow, in order to give the best results, requires a rest of six weeks or two months between lactations. During this time she should be prepared for her year's work, her tissues built up, and her digestive tract rested and cooled as much as possible. Of course nourishment must be supplied for the growing fetus.

If the cow is dry during the summer or early fall she will need very little extra care if she is on good pasture. A pasture separate from the general herd is advisable as there is then less danger of injury. During this period no more grain than is necessary should be fed as it allows the digestive system of the cow to rest, but a few pounds of oats and a little bran will often be found advisable. If the cow is in poor condition a little corn may be added, but it is not advisable to give much of such heating feeds. If it is necessary to flesh up the cow this should be done gradually.

If the dry period occurs in winter the ration should consist of 20 to 25 pounds of corn silage with a liberal allowance of legume hay and a grain ration consisting of a mixture of 3 parts ground oats, 2 parts wheat bran and 1 part oil meal; the amount of the grain ration being governed by individual requirements.

During this period the ration should be laxative in nature and should contain little of such heating feeds as corn, and feeds such as cottonseed meal and timothy hay should be avoided.

THE COW IMMEDIATELY BEFORE PARTURITION

A few days before freshening, the grain ration should be considerably reduced and at this time a mixture of 2 parts bran and 1 of oil meal is excellent as it keeps the bowels laxative. If this mixture does not give the desired effect a dose of 1 quart of raw linseed oil or 1 pound of epsom salts should be given. Freedom from milk fever and other post-parturient troubles is in large measure due to the care with which the cow is handled and fed just previous to freshening.

THE COW IMMEDIATELY AFTER PARTURITION

For a day or two after calving feed the cow bran mashes in addition to alfalfa or clover hay and a limited amount of silage. During this period warm the drinking water slightly. A mixture of bran, ground oats and oil meal may be used to replace the bran in a day or two.

It is a recognized fact that 30 days is required to put a beef steer on to full feed and at least this length of time should be given to the bringing of the dairy cow on to a full ration. This is easily seen when it is remembered that the dairy cow is not only on feed much longer than is the beef animal, but she does the same work for several years. In addition, parturition has a distinctly weakening effect on the system and the digestive functions suffer along with the others. Consequently, great care should be exercised in raising the cow's ration to the profitable maximum as a too rapid raise in feed will result in indigestion, bloat or other digestive trouble.

Beginning with 4 or 5 pounds of grain per day on the fourth or fifth day after freshening, the grain should be increased at the rate of 1 pound on every third or fourth day until the cow's maximum production of milk is reached. When this is reached, that is when the milk yield does not increase in response to an increase in grain, the grain ration should be slightly reduced and it will, as a rule, be noted that the cow will increase a little in milk production. The amount of grain then being fed is about what she should receive as any less will not give the best production and additional feed would be used for the production of body fat and consequently would be wasted so far as milk production is concerned.

THE MILKING COW

In feeding cows for milk production the main point to keep in mind is the individual cow. Each cow has her own requirements for maintenance and production and in addition attention must be paid to her likes and dislikes if the best results are to be obtained.

A cow should receive an abundance of feed, containing plenty of nutrients in the right proportions and made up of feeding stuffs that she likes. Economy must also be considered. In the corn belt the chief concentrates that have to be purchased are nitrogenous ones and so in buying these determine the cost of protein as already described.

When cows are turned out to pasture in early summer it is usually well to feed them no grain for about a month. At this time the grass is succulent and nutritious and going without grain allows the digestive system of the cow to rest. With the onset of dry weather, however, it is advisable to feed a little grain along with the summer silage or soiling crops allowed. Feeds suitable for this season of the year are cracked corn, cottonseed meal and ground oats. They keep the cow up in production during the summer and it has also been found that cows fed grain during the summer will do rather better during the following year than where fed no grain.

In winter the main part of the ration should consist of silage and legume hay, either alfalfa or clover. Allow about 25 to 35 pounds of silage and 10 to 15 pounds of hay for a 1,000 pound cow. The grain allowance necessary is determined by the production and condition of the cow. As a rule, feed 1 pound of grain for each 2½ to 4 pounds of milk produced, depending on the quantity and quality of the milk. Jerseys and Guernseys require more grain per pound of milk than do Holsteins and Ayrshires. Another simple method of determining the grain requirement is to allow 7 pounds of grain for each pound of butter fat produced. As a rule about ⅔ of the dry matter of the ration should be in the roughages. High producers and cows that are in good condition need more nitrogenous rations than do those that are poor producers or in low condition. It is not well to have a cow fat when producing milk as any beefiness tends to decrease the flow of milk. Cows should be in good condition when freshening and for a time after this they will lose weight. After this fall in weight the cow should be kept in good thrifty condition till near the end of the lactation when she should be fed more carbonaceous feeds and allowed to flesh up.

When silage is not available and no roots are grown the feeding of the dairy cow for profitable milk production is not a very easy matter. If alfalfa or clover hay is available the proposition is much simplified. Even good mixed hay is quite a help, but if timothy is the only hay available it should be sold and alfalfa bought. Timothy in good condition can usually be sold at the price for which alfalfa can be bought and the increased production brought about by the feeding of the alfalfa will considerably more than pay for the cost of hauling. If possible, dried beet pulp should also be bought to be soaked and fed with the corn fodder and alfalfa or clover hay. The concentrate part of the ration in such conditions should contain quite a large proportion of laxative feeds such as bran and oil meal, but not cottonseed meal or other constipating feeds.

Owing to the large variations in feed prices in various localities and at different times, it is not possible to recommend grain mixtures which will always be economical, but the following sample mixtures are good under the conditions mentioned provided that they can be bought at reasonable

prices. When the prices of these feeds are too high other feeds of similar character but lower price can be substituted.

The following mixtures make good grain rations when silage and legume hay are fed:

Sample A

400 lbs. Cracked Corn, Corn and Cob Meal or Hominy Feed.
200 lbs. Ground Oats.
100 lbs. Cottonseed Meal.
100 lbs. Oil Meal.

Sample B

400 lbs. Cracked Corn, Corn and Cob Meal or Hominy Feed.
100 lbs. Ground Oats.
100 lbs. Brewers' Dried Grains.
100 lbs. Cottonseed Meal.
100 lbs. Oil Meal.

Sample C

400 lbs. Cracked Corn, Corn and Cob Meal or Hominy Feed.
200 lbs. Ground Oats.
100 lbs. Gluten Feed.
100 lbs. Bran.

The following mixture would be better than either of the above in the absence of silage:

Sample D

300 lbs. Cracked Corn, Corn and Cob Meal or Hominy Feed.
100 lbs. Ground Oats.
100 lbs. Gluten Feed.
100 lbs. Bran.
200 lbs. Oil Meal.

The above are only rough guides as to the feed mixtures to use, as much depends on local markets.

THE BULL

During the first six months of life the treatment of young bulls is the same as for heifer calves, but at the end of this time they should be separated from the heifers, and begin to receive rather more grain than do the heifers.

With older bulls, where the main object is to keep them in good breeding condition, the ration should consist largely of alfalfa or clover hay and grain with a little silage. Good results can not be obtained by feeding large quantities of silage to the dairy bull as this causes over-distension of the middle and he is likely to become sluggish and slow in breeding. Not more than 10 to 15 pounds per day of silage should be fed. The grain ration should contain a good percentage of protein. Cracked corn, ground oats and bran with the addition of a little oil meal makes an excellent grain ration for the dairy bull.

SALT

Salt is essential to the dairy cow. There are three common methods of salting cows, viz., to have it before them all the time, to give them access to it at stated intervals, and to mix it with the feed.

The first of these three methods is much to be preferred and the last method is not to be advised as some cows will get more than they want

and others not enough. The requirements of a cow depend on her live weight and her milk production. The salt in the feeds will also determine to a certain extent the amount of additional salt required by the cow. As a rule about 1 oz. daily is required by a milk producing dairy cow.

All young animals and bulls as well as dry cows likewise require salt but not in such large quantities.

WATER

Water, the main constituent of milk, is very essential for milk production. From work at the Iowa Agricultural Experiment Station it has been found that 3 to 5 pounds of water are required for each pound of milk produced. This is in addition to the water in the pasture grass, silage and other feeds.

Keep the water supply pure and fresh. Being protected from all contamination by surface water, deep well water is the best. In summer water should always be available to the cows when at pasture. This water should be kept in a tank, or, if it is in a stream, it should be so protected that the cows can not stand in it and convert it into a puddle. Water should also be where the cows can obtain it on their way to and from the barn. In winter the cows should not be turned out into a windswept lot and allowed to drink ice-cold water. If it is necessary for the cows to drink outside in the winter furnish the tanks with heaters.

Water the cows in the barn if possible. Individual drinking cups have the advantage of keeping water before the cow all the time, but they also have their drawbacks. Continuous cement mangers, fitted with a faucet at one end and a drain at the other, are simpler and have many advantages. With these the cows can be very easily watered two or three times a day and the water is always fresh. Whatever the method used the cows should get all the water they want.

ORDER OF FEEDING

Much more important than the time or order of feeding is regularity. It does not do to feed a cow just when the feeder feels inclined; she should have regular meal hours. Many feed the grain before the roughages, as the cow eats her grain rapidly and then takes her time with the coarser feeds. A very good method is to put the grain on the top of the silage. The grain is sometimes fed at milking time. Hays which are likely to cause dust in the barn, and feeds, such as silage and roots, which impart taints to the milk, should be fed after milking and not before. A good method is to feed the hay two or three times a day and the silage and grain twice. This allows the cow to make better use of her food than if it were fed less often in larger quantities. Grain, if fed only once in a large quantity, is also likely to cause digestive troubles. If the cows have not access to water at all times they should be watered at least twice per day.

METHOD OF FEEDING

The most convenient way of feeding silage is with a wagon which can be filled at the silo and then pushed round in front of the cows and the silage fed with a scoop. If a few scoopfuls of silage are weighed occasionally the silage can be fed with a fair degree of accuracy.

Baled hay is very convenient for feeding. If home grown hay is used place the hay chute so the feeding may be done with the least trouble. The allowance of hay, as of silage, should be weighed occasionally.

The mixtures and quantities of grain to be fed should be determined for

each cow individually. Where this is not convenient a general mixture which is found to be economical can be made up and weighed out.

There are four general methods of feeding the grain ration.

1. A cabinet of drawers, each large enough to hold one day's grain allowance for a cow, is provided. Each day the allowance for each cow is weighed and put in a drawer and at feeding time the cabinet is wheeled in front of the cows.

2. A row of covered boxes large enough to hold a week's feed is built in front of the cows and each week the grain is weighed and placed therein. At feeding time each cow's allowance is measured out with a scoop.

3. A feed wagon divided into compartments may be used. There is a separate feed in each compartment and at feeding time the allowances are weighed out on a spring balance scale which is attached to the wagon.

4. A mixture known to be economical can be made up and measured or weighed out.

When it is convenient to measure feeds rather than weigh them the following table will prove convenient as it gives the weight per quart of some of the commoner feeds. It can also be used as a guide to the bulkiness of a grain ration—bulky feeds having a low weight per quart.

TABLE IX. APPROXIMATE WEIGHT PER QUART OF SOME COMMON FEEDS*

Feeding Stuffs	Weight Per Qt. Lbs.	Feedings Stuffs	Weight Per Qt. Lbs.
Shelled Corn	1.7	Barley	1.5
Corn Meal	1.5	Malt Sprouts	.6
Corn and Cob Meal	1.4	Brewers' Dried Grains	.6
Hominy Feed	1.1	Buckwheat	1.4
Gluten Feed	1.3	Cottonseed Meal	1.5
Gluten Meal	1.7	Linseed Oil Meal, O. P.	1.1
Germ Oil Meal	1.4	Linseed Oil Meal, N. P.	.9
Corn Bran	.5	Beans	1.7
Wheat	1.9	Cowpeas	1.7
Wheat Shorts	.8	Field Peas	2.1
Wheat Bran	.5	Soybeans	.8
Rye	1.7	Dry Beet Pulp	.6
Oats, whole	1.0	Distillers' Dried Grains	.6
Oats, ground	.7	Cane Molasses	3.0

With each of these methods there should be a simple feed sheet showing what each cow is to receive. In this way accurate feeding will be done and the maximum and most economical production of milk will be obtained.

PRODUCTION POINTERS

1. High producing cows are the basis of profitable dairying; the most economical results can not be obtained with poor producers.

2. A good sire will rapidly grade up a herd to high production; any pure bred sire will not do—he must be able to transmit producing ability to his offspring.

3. The care given to dairy heifers will determine to a great extent the profits they will make when they join the milking herd.

4. A good cow will respond to good treatment and even a poor cow will increase in production if she is properly handled.

5. Without liberal feeding liberal returns can not be obtained. A heavy producing cow can not do her best work unless she is well fed.

6. The milk scales and the Babcock tester separate the good cows from the poor cows.

* From the extensive tables in Feeds and Feeding, 16th edition, by Henry and Morrison.